tions prevailing in the island, and at least not better adapted than the species from which they sprung. Or, in other words, that they did not originate in advantageous response to those local conditions. A large amount of facts and considerations has been brought forward by the author in order to justify this conclusion.

These conclusions provide us with a strong argument against the hypothesis of a slow and gradual evolution by small and almost invisible steps, and for the theory of their production by mutations. In the rare cases of rapid dispersal of new species a better adaptation may of course be assumed as one of the chief factors, but on the average the dispersal is very slow in the beginning, giving no argument in favor of this view.

Furthermore these considerations lead to the view that wide distribution and commonness are chiefly dependent on age, and only rarely on adaptation. In every family the genera with the widest distribution may be considered as the oldest, those with a smaller domain as younger, and the local endemics as the youngest of all. These principles will be used in subsequent studies to draw pedigrees of families. But the studies made by the author up to this time go to show that nearly all families have the same general type of distribution, that evolution of forms is on the average indifferent, and that most of the so-called adaptations are of no special advantage to their possessors.

Another argument relates to the possible size of mutations. It is often assumed that mutations must of necessity be small, considering that it seems probable that only one unit-factor will be changed at a time. This conception seems to the author to be an unnecessary handicap to the theory of mutation and he proposes that it should be replaced by the hypothesis that no specific change is too great to appear in one mutation. The difference between endemic species of Ceylon and their nearest allies is often very large, as may be deduced from the fact that they are accepted as well-marked Linnean species by such authorities as Trimen and Hooker. But in many cases they are even larger. For instance, *Coleus elongatus,* which occurs only on the top of Ritigala and here only in about a dozen of individuals, differs so much from all other *Colei,* that it may well be regarded as subgenerically distinct. And for the 17 endemic genera, which have only one species each, it seems at least very probable that the whole genus has arisen at a single step.

In concluding I might state that my own studies on the production of new forms among the Œnotheras have of late led me to the conclusion that mutations are in many cases of a far more complicated nature than has been assumed until now. Many of them, as for instance the production of *O. rubrinervis, O. nanella* and *O. gigas,* involve the simultaneous change of two or more characters, in some cases of quite a large number of unit-factors. Why these changes should so regularly go together, we do not, as yet, know, but the fact goes to increase the analogy between the experimental mutations of these plants and the mutations in the wild condition of the Ceylon endemics.

From the facts adduced by Willis, and reviewed in this article, it seems obvious that the parallelism of natural and experimental mutations is a very close one.

HUGO DE VRIES

### ELECTRICAL DISCHARGE BETWEEN CONCENTRIC CYLINDRICAL ELECTRODES

IN operating vacuum tubes we invariably use an induction coil or an electrostatic machine. The discharge in either case is never quite steady and hence these methods of operation do not lend themselves well to a critical study of the growth of the cathode dark spaces. A steady, and of course continuous, discharge may be had if the current is drawn from a high potential storage battery. Ordinarily it takes more cells than are available; however, by a right choice of conditions a rather extended study may be made with direct current potentials of less than 1,000 volts. The following experiments with concentric cylindrical electrodes were performed recently by the writer in class demonstration.

The discharge vessel consists of an ordinary

three-quart battery jar. A hole bored through the bottom receives the evacuating tube, the junction being made airtight with ordinary sealing wax. The lip of the jar is ground flat to receive the plate glass lid. The junction here is made by means of the frequently used half-and-half wax, beeswax and resin. This wax because of its low melting point admits of easy removal of the glass plate. The electrodes are concentric cylinders and may well be made of sheet aluminum—one electrode to fit snugly the inner wall of the jar, and the other mounted on a cylinder of glass tubing about 1½ inches in diameter, which in turn is supported accurately concentric by sealing wax from the bottom of the jar. Outside connections to the electrodes are made by fine bare copper wire run out through the waxed joints. The assembled discharge vessel is shown at *a* in Fig. 1.

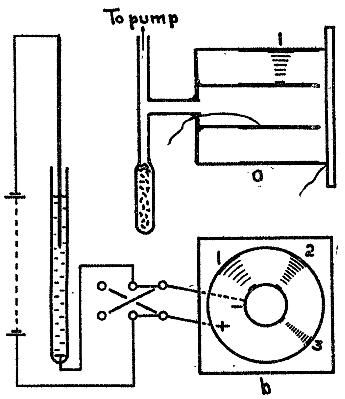


FIG. 1.

The vessel may be exhausted by a Gaede mercury or a Gaede piston pump and, if desired, the vacuum carried farther by the use of charcoal and liquid air, though the latter is not necessary. The potential employed by the writer to produce the discharge was furnished by a cabinet of high potential storage cells of 1,000 volts.

Two methods of operating were employed. In the first an adjustable water resistance is connected in series with the cells and discharge vessel as shown at *b* in Fig. 1. When the vacuum is right a beautiful discharge will make its appearance as patches of light on the electrodes. These patches of light, when there is considerable resistance in the circuit and the vacuum is not very high, will be opposite each other and the discharge, as a whole, will wander about, sometimes swinging entirely around, or at times travelling to the edges of the electrodes, only to break away and move to some other point. The movement of the cathode glow (which is the smaller and hence the brighter) is similar to that of the cathode star over the surface of mercury in a mercury vapor lamp. These areas grow as the vacuum improves when ultimately the entire surface of each electrode is covered. Or, with the vacuum kept constant, the areas may be made to increase in size by cutting out resistance. Hence by improving the vacuum and at the same time cutting out resistance the discharge, if the inner cylinder is made cathode, grows rapidly into a brilliant bull's-eye. The appearance is very realistic, for if now resistance is cut in, the dark space around the cathode (as is evident after a moment's reflection) grows smaller, and *vice versa*. Its

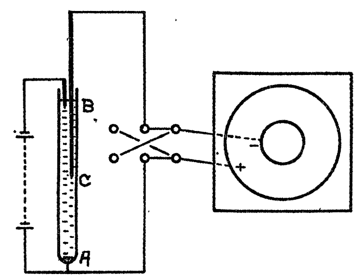


FIG. 2.

outline is exceedingly sharp and perfectly steady, and yet, though the discharge appears very brilliant, the current required may not exceed 20 milliamperes.

This form of discharge vessel offers an interesting method for the study of the striations and their relative spacing with reference to the impressed discharge potentials. These effects are best shown when the vacuum is not too high and the discharge potential is adjusted to give a patch on the cathode, which

we will take as the inner cylinder, of about one square centimeter in area. Under these conditions the Faraday dark space should be about 8 mm. in length, and the Crookes dark space should be just visible between the velvety cathode glow and the cathode electrode. Another prerequisite is that the discharge must not cling to the edge of the aluminum electrodes, but should occupy some intermediate position as shown at 1 in *a*, Fig. 1. In this position the characteristics of the discharge are shown with exceeding clearness. If now some additional resistance is cut in, the area of the discharge will become less, the Faraday dark space will shorten, the positive column will move towards the cathode, and the number of striæ in it will increase, the extra striæ being, as it were, drawn out of the anode. The configuration is perfectly steady except that the discharge, as a whole, is liable to wander. This transition may be continued by a still further increase of the resistance in the circuit, the dark space becoming ever shorter, the positive column lengthening and at the same time shrinking in area and the striæ increasing in number, all without loss of outline or brightness. Finally, the discharge will cease. The various stages are suggested at 1, 2, 3 in *b*, Fig. 1.

In the second method the discharge vessel with its commutator is placed in a derived circuit (Fig. 2). This arrangement enables the discharge potential to be continuously varied over a wide range, and hence for a given vacuum the relation between the length of the dark space and the impressed voltage may be exhibited. Again this arrangement enables the minimum potential to be readily determined that will maintain a discharge. As an example, for a given vacuum with the resistance $AC$ equal to 1/3 that of $AB$ the discharge was observed to just pass, indicating that the potential necessary was 330 volts.

Additional phases of the experiment will suggest themselves to the operator.

CHAS. T. KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
March 4, 1916

## UTAH ACADEMY OF SCIENCES

THE ninth annual convention of the Utah Academy of Sciences was held in the chemistry lecture room of the University of Utah. Three sessions were held: one at eight P.M., Friday, April 7, one at ten A.M., Saturday, April 8, and the closing session at two P.M. of the same day. Dr. Harvey Fletcher presided at all of the sessions.

Dr. E. G. Peterson, U. A. C., and Professor Carl F. Eyring, B. Y. U., were elected to fellowships in the academy. The following were elected members: Professor George B. Caine, U. A. C., Dean Milton Bennion, U. U., Professor Newton Miller, U. U., Professor A. L. Matthews, U. U., Dr. George S. Snoddy, U. U., Miss Hazel L. Morse, East High School, Salt Lake City, C. Arthur Smith, East High School, Salt Lake City, C. Oren Wilson, East High School, Salt Lake City, Professor Estes P. Taylor, U. A. C., Dr. A. P. Henderson, B. Y. U., and Edgar M. Ledyard, Salt Lake City.

Captain Francis Marion Bishop, a companion of Major Powell in his famous explorations of the Uinta Mountains, was elected to honorary life membership.

The following officers were elected for the ensuing year:

*President*—Dr. Frank Harris, U. A. C., Logan.

*First Vice-president*—Dr. L. L. Daines, U. U., Salt Lake City.

*Second Vice-president*—Professor Carl F. Eyring, B. Y. U., Provo.

*Councillors*—Dean J. L. Gibson, U. U., Dr. W. E. Carroll, U. A. C., W. D. Neal, Salt Lake City.

The following lectures and papers were presented:

"Industrial Research in U. S. A.," by Dr. Harvey Fletcher, B. Y. U.

"The Alkali Content of Certain Utah Soils," by Dr. Frank S. Harris, U. A. C.

"The Agricultural College and Scientific Research," by Dr. E. G. Peterson, U. A. C.

"Selecting Holstein-Friesian Bulls by Performance," by Dr. W. E. Carroll, U. A. C.

"Peyote, an Indian Narcotic," by A. O. Garrett, East High School, Salt Lake City.

"An Epidemic of Colds with *Micrococcus catarrhalis* as Causative Agents," by Dr. L. L. Daines, U. U.

"The First Recorded Case of Rabies in Utah," by Dr. L. L. Daines, U. U.

"Botulinus Poisoning from a Vegetable Source," by Dr. L. L. Daines, U. U.

"Comparison of Methods of Treatment for